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Tsuto

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(54) **METHOD OF AND APPARATUS FOR SCANNING SHEET**

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(52) **U.S. Cl.** **355/18**; 358/474; 358/498; 271/225

(58) **Field of Search** 358/474, 496, 358/498; 271/10.09, 10.01, 225; 399/361, 365, 377, 397; 355/18; 378/182, 184, 185, 188

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(57) **ABSTRACT**

An image information reading apparatus has a sheet feeder for feeding a stimulable phosphor sheet and a reading unit for scanning the stimulable phosphor sheet two-dimensionally. The reading unit has a storage zone for separating the stimulable phosphor sheet in its entirety from the sheet feeder and temporarily storing the stimulable phosphor sheet. The reading unit does not require a nip releasing mechanism for releasing the stimulable phosphor sheet from a nipping action of the sheet feeder when the stimulable phosphor sheet is scanned.

11 Claims, 7 Drawing Sheets

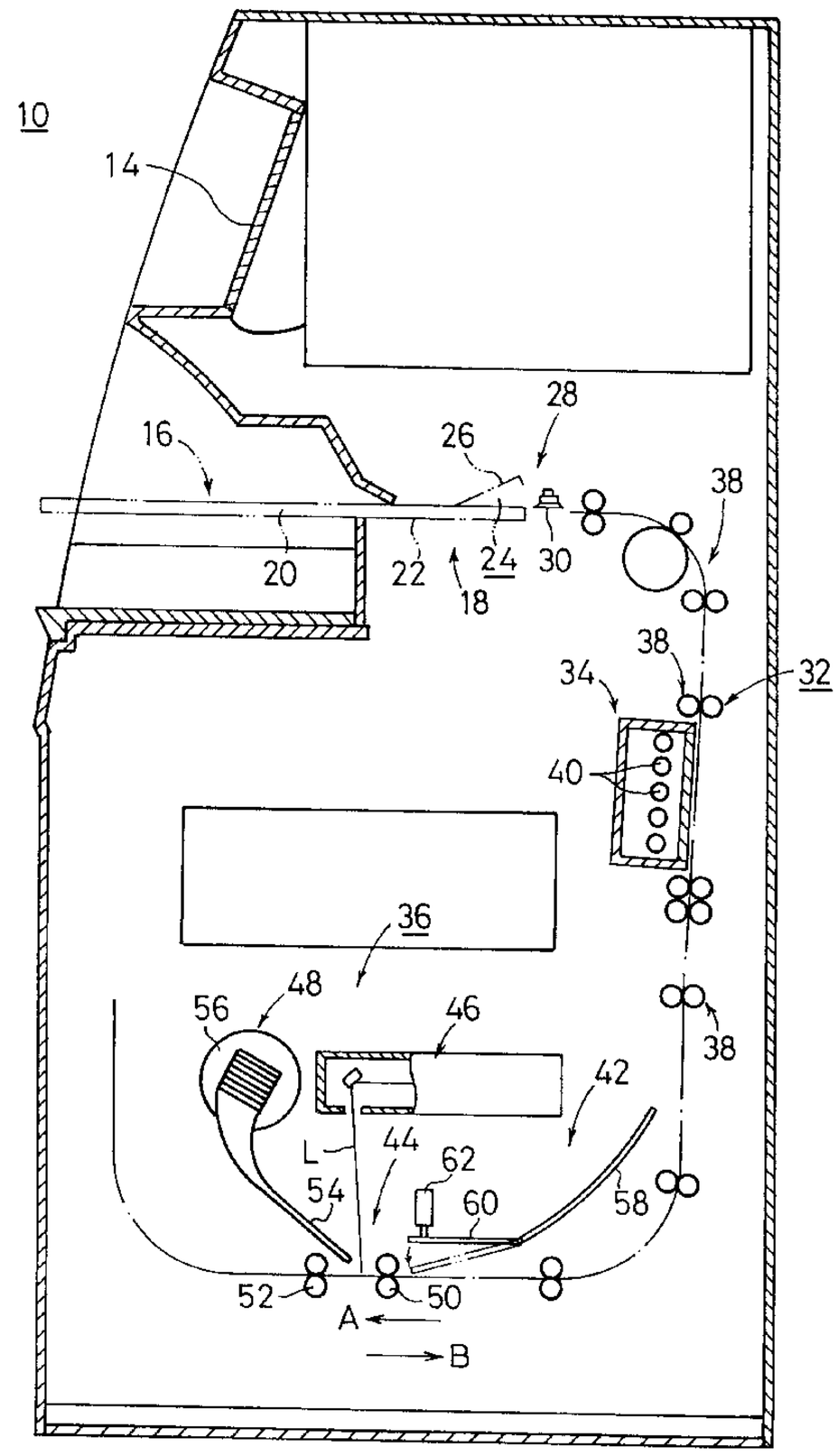

FIG.1

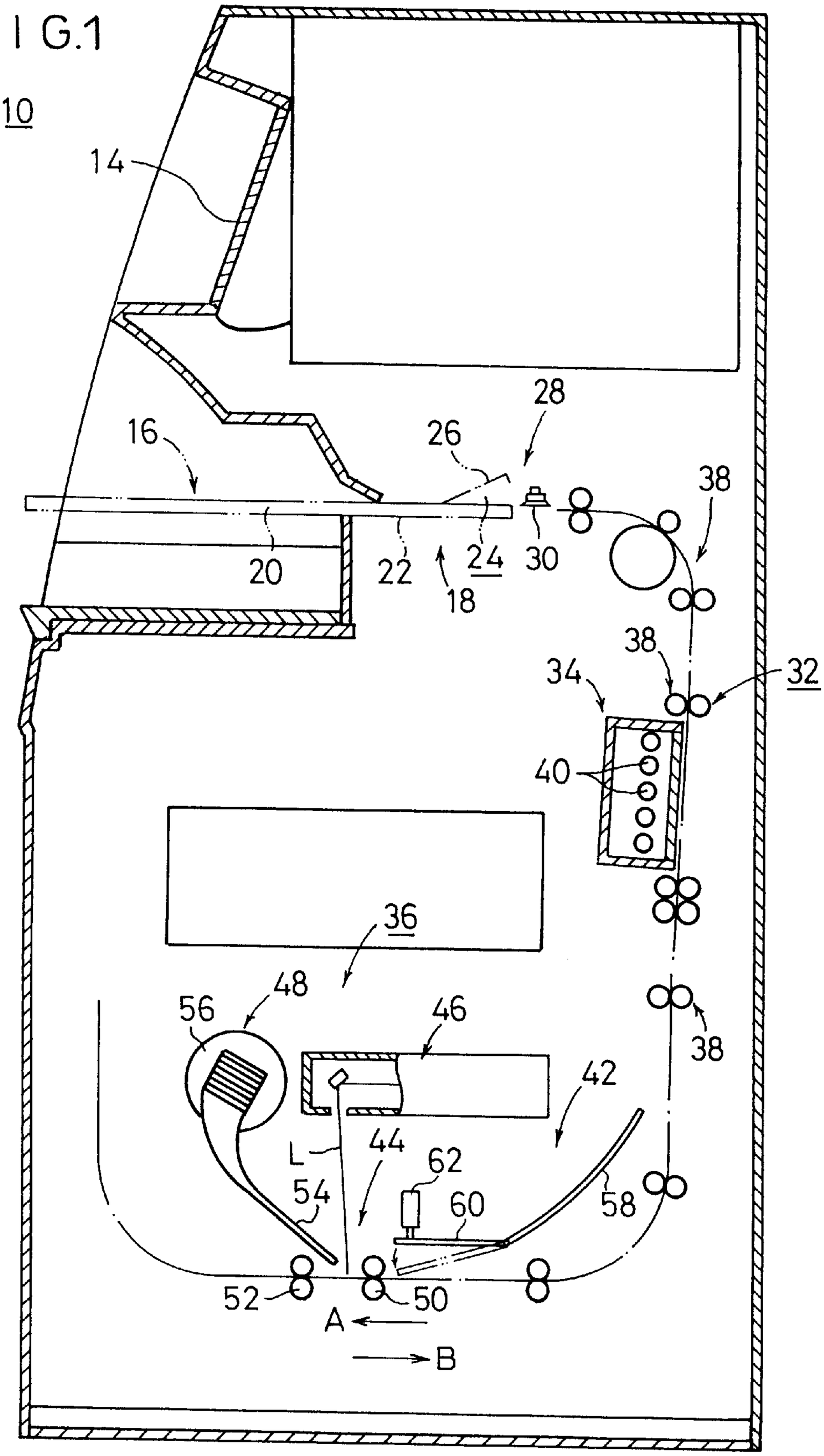
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FIG. 2

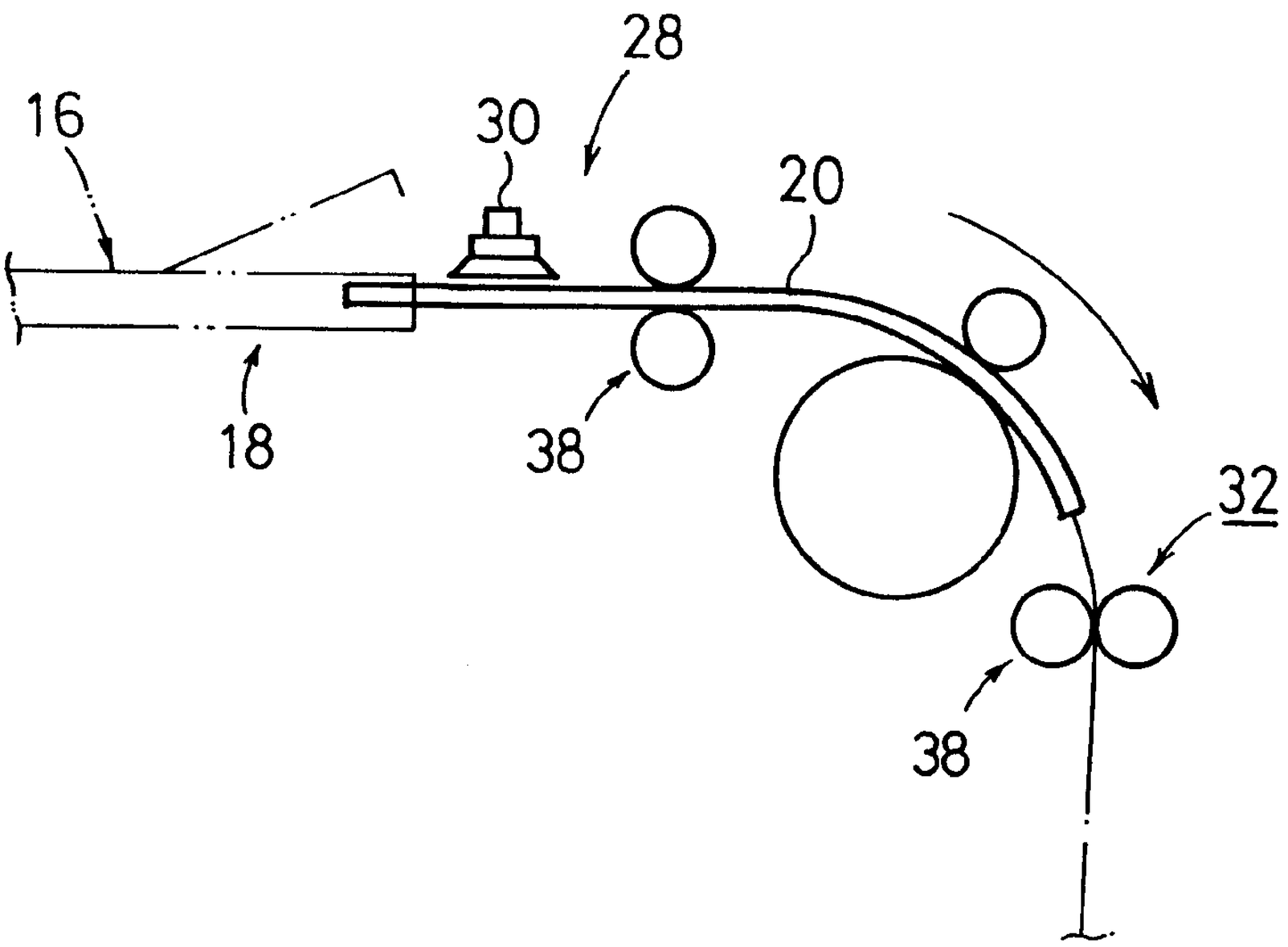

FIG. 3

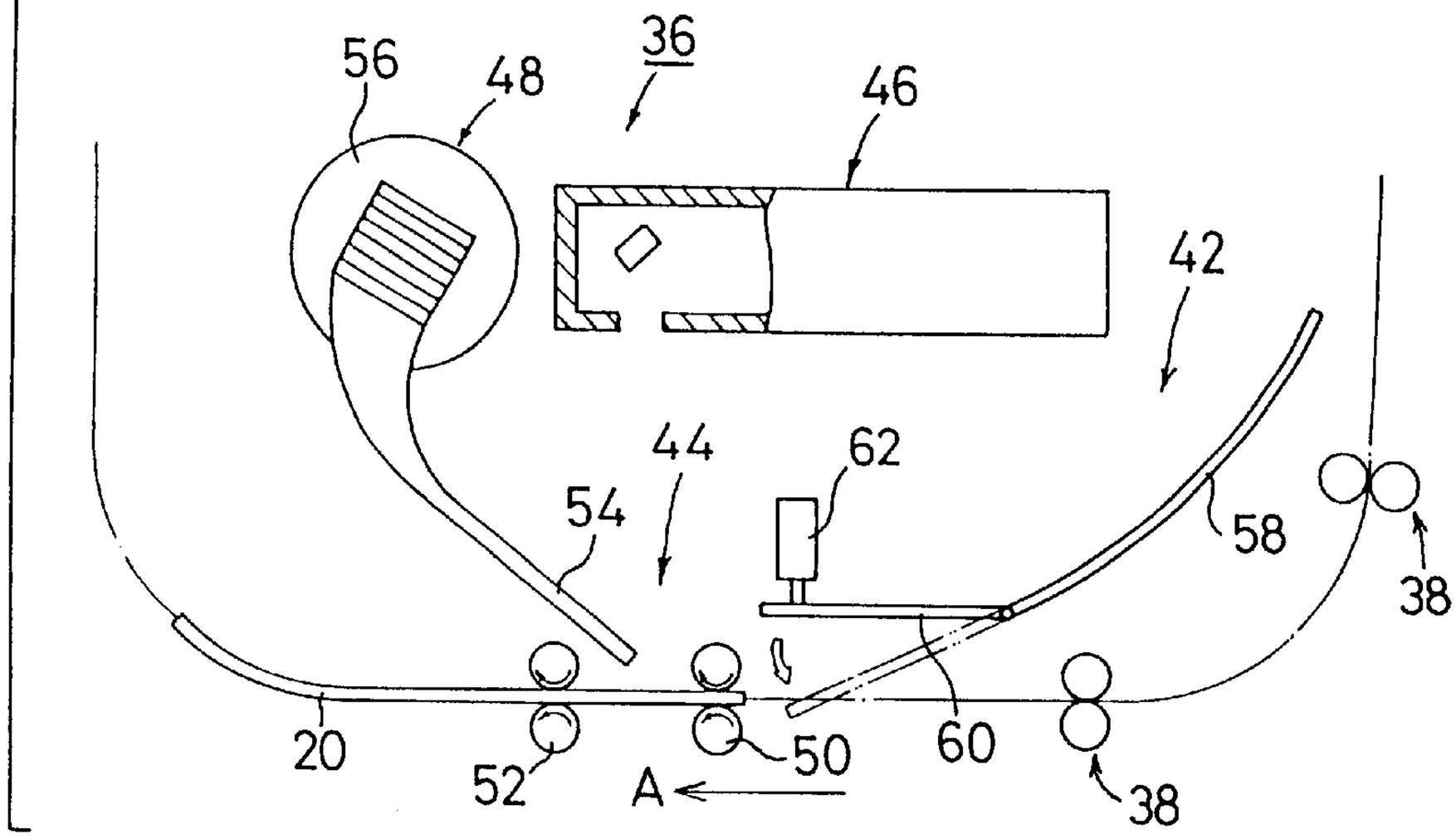
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FIG. 4

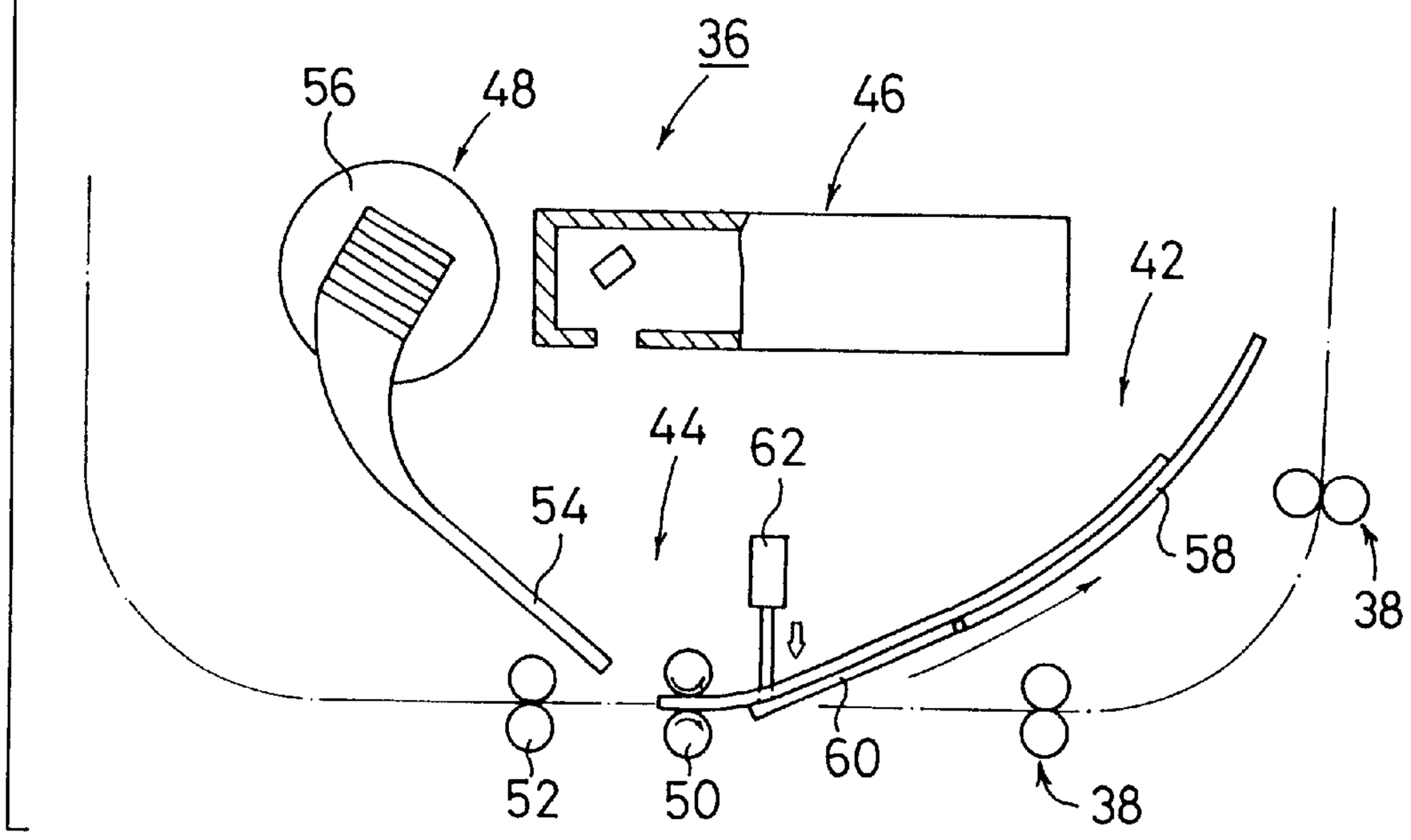
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FIG. 5

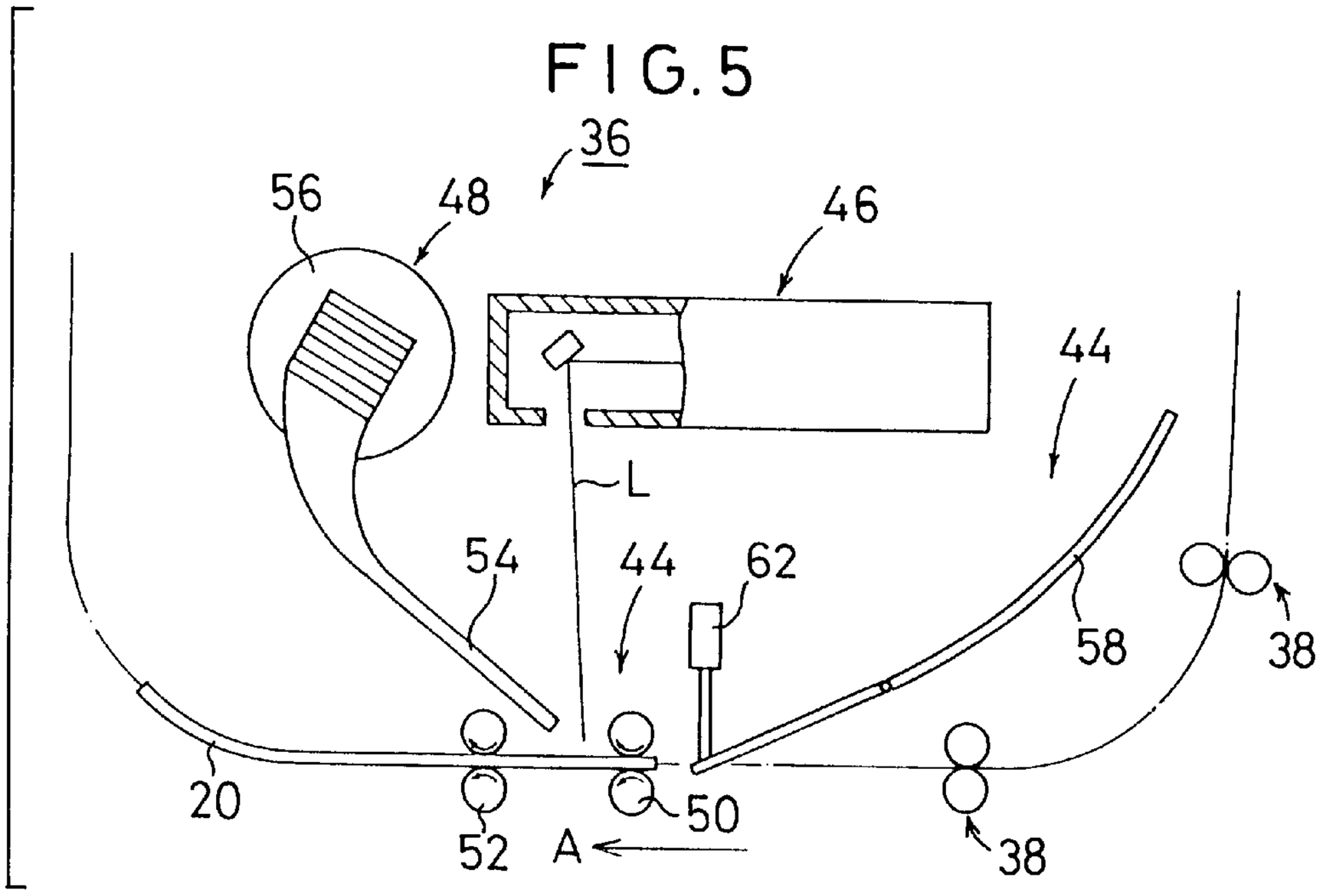
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FIG. 6

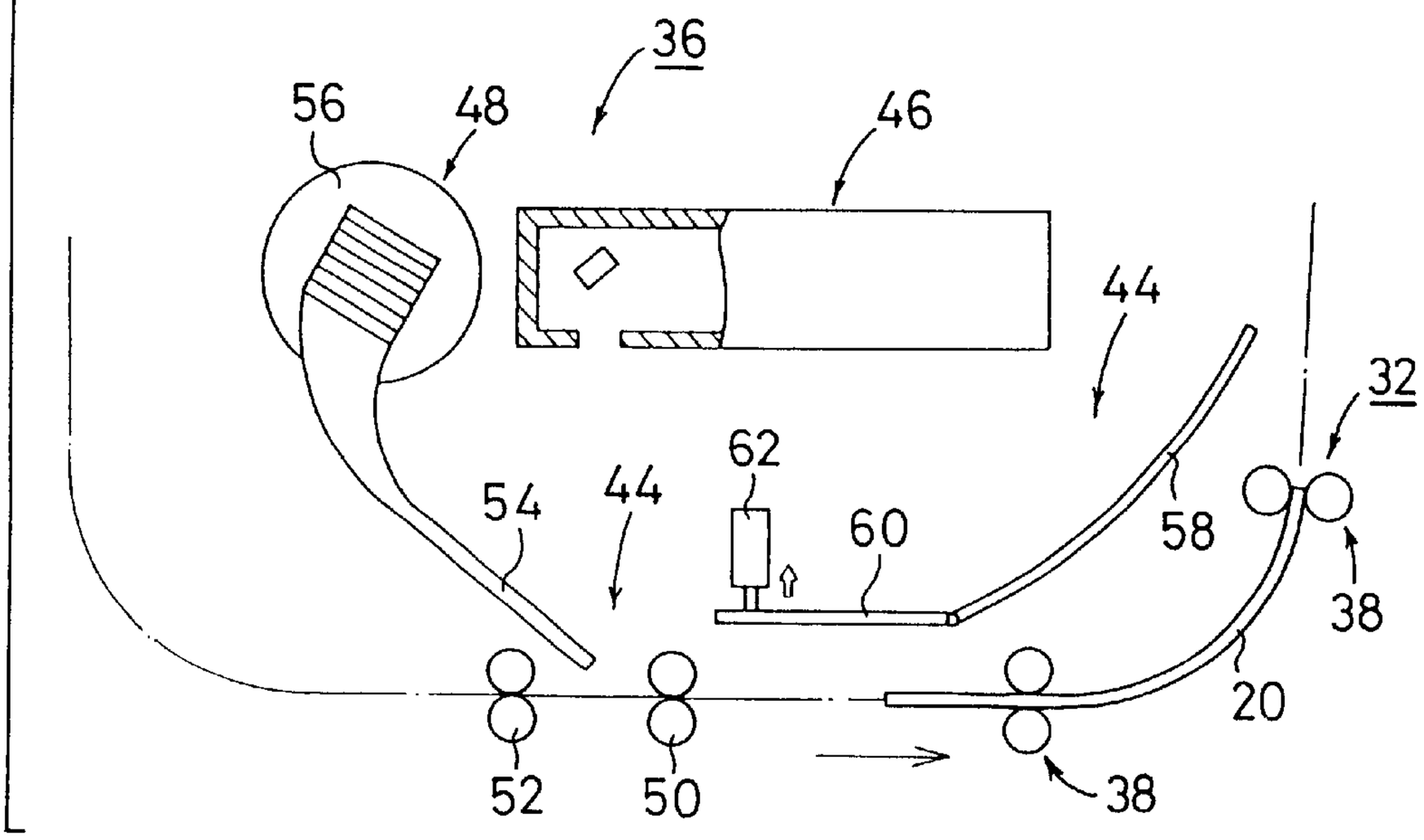
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FIG. 7

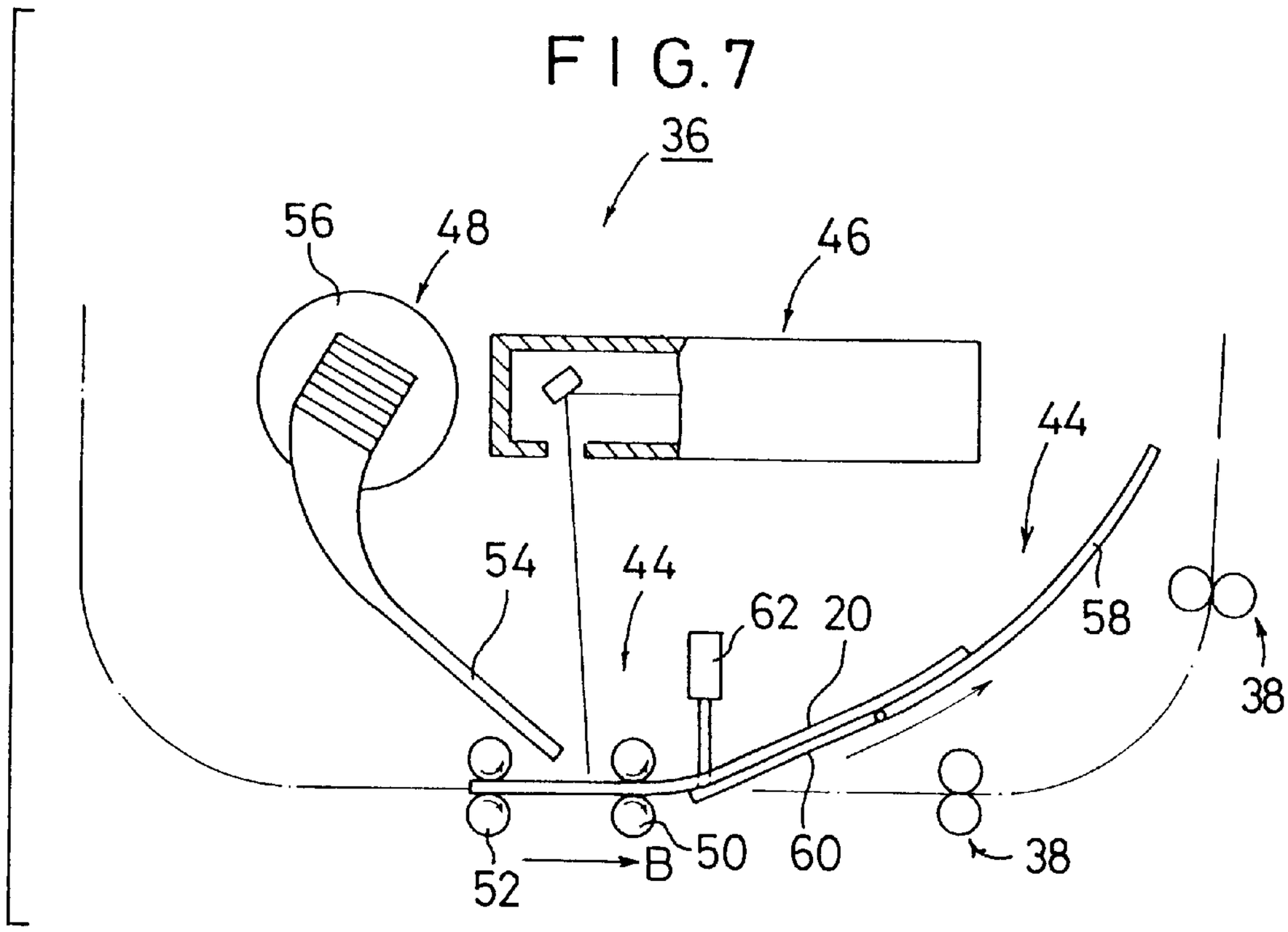

FIG. 8

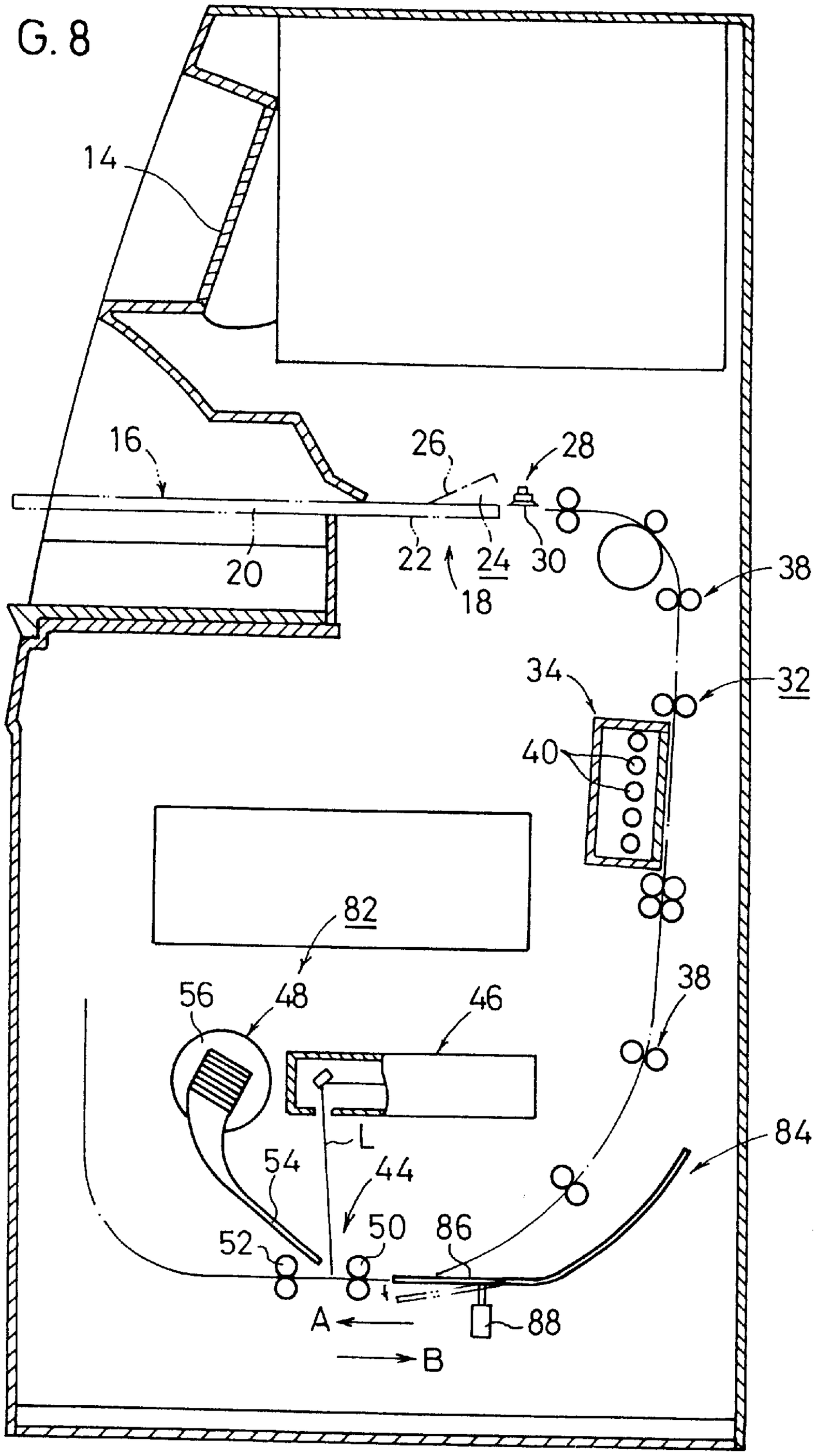
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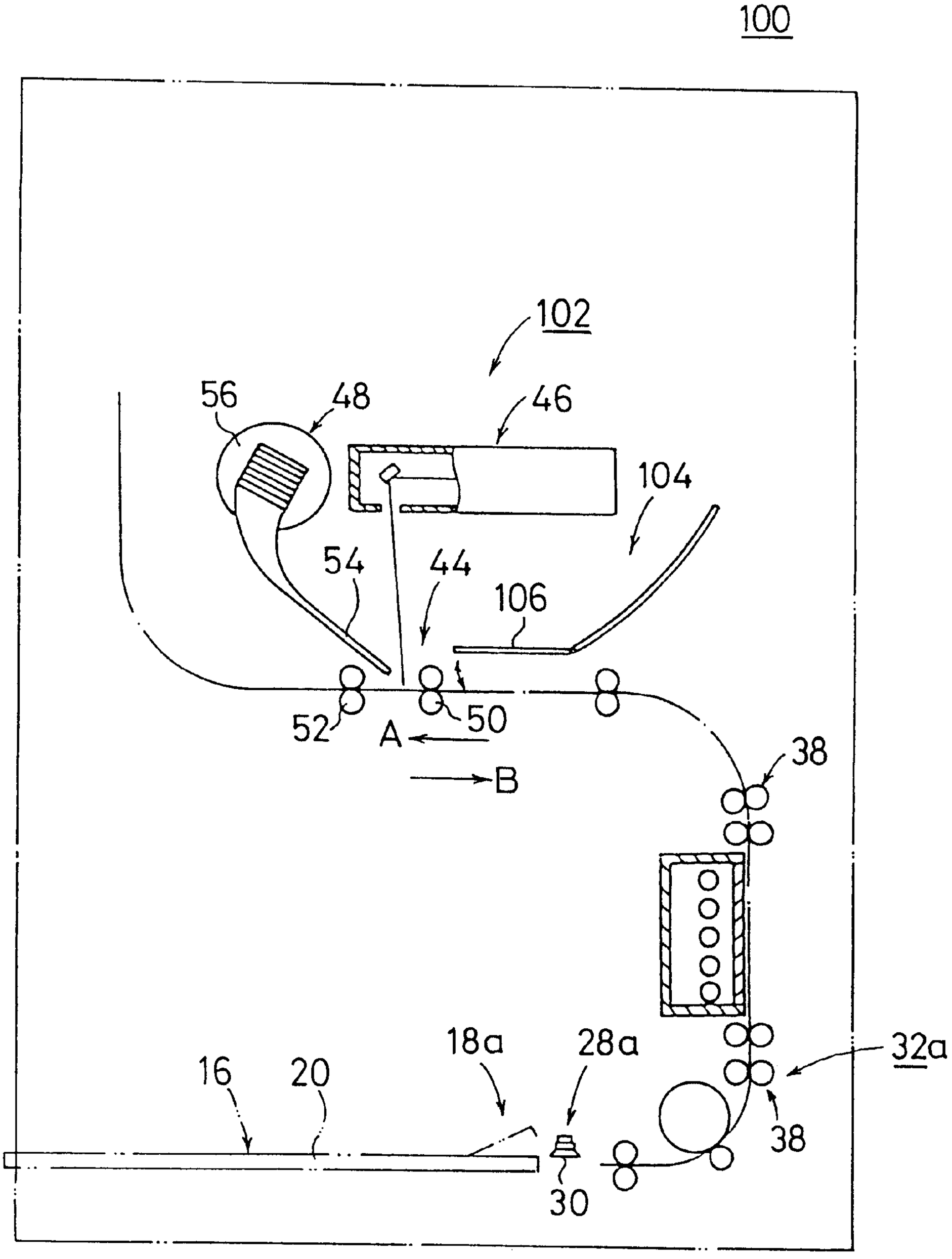
FIG. 9



METHOD OF AND APPARATUS FOR SCANNING SHEET

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of and an apparatus for applying a light beam to a sheet such as a photographic film, a stimulable phosphor sheet, or the like to scan the sheet.

2. Description of the Related Art

There is known a system for recording radiation image information of a subject such as a human body with a stimulable phosphor, and reproducing the recorded radiation image information on a photosensitive medium such as a photographic film, or displaying the recorded radiation image information on a display device such as a CRT or the like.

The stimulable phosphor is a phosphor which, when exposed to an applied radiation (X-rays, α-rays, γ-rays, electron beams, ultraviolet radiation, or the like), stores a part of the energy of the radiation, and, when subsequently exposed to applied stimulating rays such as visible light, emits light in proportion to the stored energy of the radiation. Usually, a sheet provided with a layer of the stimulable phosphor is used as a stimulable phosphor sheet and stored in a cassette in the art.

The above known system includes an image information reading apparatus (scanning apparatus) which comprises a reading unit (scanning unit) for reading the recorded radiation image information from the stimulable phosphor sheet, and an erasing unit for erasing remaining image information from the stimulable phosphor sheet after the recorded image information has been read. The image information reading apparatus operates as follows: A cassette housing a stimulable phosphor sheet with radiation image information which has been recorded therein by an external exposure device is inserted into a loading unit of the image information reading apparatus. When the lid of the cassette is opened, the stimulable phosphor sheet is removed from the cassette by a suction mechanism, and then fed to the reading unit by a sheet feeding mechanism (sheet feeder). After the recorded image information is read from the stimulable phosphor sheet by the reading unit, the stimulable phosphor sheet is delivered to the erasing unit where any remaining radiation image information is erased from the stimulable phosphor sheet. The stimulable phosphor sheet is then returned into the cassette in the loading unit.

The above system also includes an image information reproducing apparatus (scanning apparatus) for reproducing radiation image information on a photographic photosensitive medium such as a photographic film or the like. The image information reproducing apparatus has a magazine which contains a plurality of photographic photosensitive mediums. In operation, one of the photographic photosensitive mediums at a time is removed from the magazine and delivered to a sheet feeding mechanism (sheet feeder), which feeds the photographic photosensitive medium to a recording unit (scanning unit). In the recording unit, the radiation image information obtained from the stimulable phosphor sheet is recorded on the photographic photosensitive medium.

In the image information reading apparatus and the image information reproducing apparatus, when a sheet-like member such as the stimulable phosphor sheet or the photographic photosensitive medium is fed to the scanning unit

such as the reading unit or the recording unit by the sheet feeding mechanism, the sheet feeding mechanism needs to release the sheet-like member in order to allow only an auxiliary scanning feed means of the scanning unit to feed the sheet-like member highly accurately in an auxiliary scanning direction. Since the sheet feeding mechanism has a roller pair for nipping the sheet-like member while it is feeding the sheet-like member, a nip releasing mechanism is required to release the roller pair from the sheet-like member when the sheet-like member is transferred from the sheet feeding mechanism to the auxiliary scanning feed means. However, the nip releasing mechanism makes the apparatus complex in structure and results in a considerable increase in the cost of the apparatus.

SUMMARY OF THE INVENTION

It is a major object of the present invention to provide a method of and an apparatus for scanning a sheet-like member highly accurately with a simple and inexpensive arrangement without the need for a special mechanism for releasing the sheet-like member from a gripping action of a feeder.

The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings in which preferred embodiments of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic vertical cross-sectional view of an image information reading apparatus according to a first embodiment of the present invention;

FIG. **2** is a side elevational view showing the manner in which a stimulable phosphor sheet is removed from a cassette in the image information reading apparatus shown in FIG. **1**;

FIG. **3** is a side elevational view showing the manner in which the stimulable phosphor sheet is fed by an auxiliary scanning feed means in the image information reading apparatus shown in FIG. **1**;

FIG. **4** is a side elevational view showing the manner in which the stimulable phosphor sheet is stored in a storage zone in the image information reading apparatus shown in FIG. **1**;

FIG. **5** is a side elevational view showing the manner in which the stimulable phosphor sheet is read in the image information reading apparatus shown in FIG. **1**;

FIG. **6** is a side elevational view showing the manner in which the stimulable phosphor sheet is sent to a feeder after it has been read in the image information reading apparatus shown in FIG. **1**;

FIG. **7** is a side elevational view showing the manner in which the stimulable phosphor sheet is read when it is fed to the storage zone in the image information reading apparatus shown in FIG. **1**;

FIG. **8** is a schematic vertical cross-sectional view of an image information reading apparatus according to a second embodiment of the present invention; and

FIG. **9** is a schematic vertical cross-sectional view of an image information reading apparatus according to a third embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows in schematic vertical cross section an image information reading apparatus (scanning apparatus) **10** according to a first embodiment of the present invention.

The image information reading apparatus **10** has a touch panel **14** in an upper left portion of the front wall of an apparatus housing. The touch panel **14** serves as a scanning control console operable by the operator for controlling the image information reading apparatus **10** and a monitor for displaying information for the operator. The image information reading apparatus **10** also has a cassette loading unit **18** disposed below the touch panel **14** for loading a cassette **16** removably therein. The cassette **16** comprises a casing **22** for storing a stimulable phosphor sheet (sheet-like member) **20** and a lid **26** for openably closing an opening **24** in the casing **22**. The cassette loading unit **18** has an opening/closing means (not shown) for opening and closing the lid **26**.

The cassette loading unit **18** also has a sheet delivery mechanism **28** for removing the stimulable phosphor sheet **20** from the cassette **16** and returning the stimulable phosphor sheet **20** into the cassette **16** after recorded radiation image information has been read and any remaining radiation image information has been erased from the stimulable phosphor sheet **20**. The sheet delivery mechanism **28** has a plurality of suction cups **30** communicating with a negative pressure source (not shown).

The image information reading apparatus **10** includes an erasing unit **34** and a reading unit (scanning unit) **36** which are positioned below and connected to the sheet delivery mechanism **28** via a sheet feeder **32**. The sheet feeder **32** has a plurality of roller pairs **38** which jointly make a vertical feed path. The erasing unit **34** comprises a plurality of erasing light sources **40** disposed along the vertical feed path.

The reading unit **36** comprises a storage zone **42** for separating the stimulable phosphor sheet **20** in its entirety from the sheet feeder **32** and temporarily storing the stimulable phosphor sheet **20**, an auxiliary scanning feed means **44** for feeding the stimulable phosphor sheet **20** separated from the sheet feeder **32** in an auxiliary scanning direction indicated by the arrow A or B, an optical system (optical beam deflecting scanning means) **46** for applying a laser beam L to the stimulable phosphor sheet **20** which is being fed in the auxiliary scanning direction, in a main scanning direction that is substantially perpendicular to the auxiliary scanning direction, and a light guiding system **48** for photoelectrically reading light which is emitted from the stimulable phosphor sheet **20** upon exposure to the laser beam L applied thereto.

The auxiliary scanning feed means **44** comprises first and second roller pairs **50**, **52** spaced horizontally from each other and rotatable in synchronism with each other. The light guiding system **48** comprises a light guide **54** disposed in a position where the stimulable phosphor sheet **20** is scanned by the laser beam L and extending along the main scanning direction, and a photomultiplier **56** mounted on the upper end of the light guide **54**.

The storage zone **42** has an upwardly curved guide plate **58** whose dimension or length is commensurate with the length of the stimulable phosphor sheet **20** in the direction in which it is fed. The guide plate **58** has an end close to the first roller pair **50**, to which there is swingably connected a movable guide plate **60** that can be angularly moved by an actuator **62** such as a solenoid to feed the stimulable phosphor sheet **20** selectively into the storage zone **42** and the sheet feeder **32**. The movable guide plate **60** and the actuator **62** jointly serve as a path switcher.

Operation of the image information reading apparatus **10** will be described below with respect to a method of scanning a sheet-like member according to the first embodiment of the present invention.

The stimulable phosphor sheet **20**, with radiation image information of a subject such as a human body or the like recorded therein by an exposure device (not shown), is stored in the cassette **16** in a light-shielded condition, and set in the cassette loading unit **18** of the image information reading apparatus **10**. When the cassette **16** is loaded into the cassette loading unit **18**, the lid **26** of the cassette **16** is angularly moved to a certain angular position by an unlocking means (not shown) in the cassette loading unit **18**, thereby opening the opening **24**.

Then, the sheet delivery mechanism **28** is operated to move the suction cups **30** into the cassette **16**, and the suction cups **30** attract the stimulable phosphor sheet **20** in the cassette **16**. The suction cups **30** which is attracting the stimulable phosphor sheet **20** then moves out of the cassette **16** toward the sheet feeder **32** until the leading end of the stimulable phosphor sheet **20** is gripped by one of the roller pairs **38** of the sheet feeder **32** (see FIG. **2**). Then, the suction cups **30** release the stimulable phosphor sheet **20**, which is now taken over by the sheet feeder **32**. The sheet feeder **32** is actuated to feed the stimulable phosphor sheet **20** through the erasing unit **34** to the reading unit **36**.

In the reading unit **36**, the first and second roller pairs **50**, **52** rotate in their normal direction in synchronism with each other to feed the stimulable phosphor sheet **20** in the auxiliary scanning direction indicated by the arrow A. When the trailing end of the stimulable phosphor sheet **20** is gripped by the first and second roller pairs **50**, **52** (see FIG. **3**), the first and second roller pairs **50**, **52** are stopped against rotation, and the solenoid **62** is energized to turn the movable guide plate **60** from the solid-line position to the two-dot-and-dash-line position in FIG. **3**, providing a path toward the storage zone **42**.

Then, as shown in FIG. **4**, the first and second roller pairs **50**, **52** are reversed to feed the stimulable phosphor sheet **20** gripped thereby onto the guide plate **58** of the storage zone **42** while being guided by the movable guide plate **60**. The stimulable phosphor sheet **20** is completely separated from the sheet feeder **32** and temporarily stored in the storage zone **42**.

The first and second roller pairs **50**, **52** then rotate again in their normal direction to feed the stimulable phosphor sheet **20** gripped thereby in the auxiliary scanning direction indicated by the arrow A, as shown in FIG. **5**. The optical system **46** is energized to apply the laser beam L to the stimulable phosphor sheet **20** in the main scanning direction. Upon exposure to the laser beam L, the stimulable phosphor sheet **20** emits light proportional to the recorded radiation image information, and the emitted light is guided by the light guide **54** to the photomultiplier **56**, which photoelectrically reads the radiation image information recorded in the stimulable phosphor sheet **20**.

After the recorded radiation image information has been read from the stimulable phosphor sheet **20** by the reading unit **36**, the solenoid **62** is de-energized to turn the movable guide plate **60** upwardly (see FIG. **6**). The stimulable phosphor sheet **20** is then fed back by the sheet feeder **32** into the vertical feed path. While the stimulable phosphor sheet **20** is being fed upwardly in the vertical feed path, any remaining image information in the stimulable phosphor sheet **20** is erased by the erasing light sources **40** of the erasing unit **34** (see FIG. **1**). The stimulable phosphor sheet **20** is then returned by the sheet delivery mechanism **28** into the cassette **16**, which is then pulled out of the cassette loading unit **18**. At this time, the lid **26** is turned toward the casing **22** by the opening/closing means to close the opening **24**.

Therefore, the cassette **16** with the opening **24** closed is removed from the image information reading apparatus **10**.

In the first embodiment, as described above, the reading unit **36** has the storage zone **42** for temporarily storing the stimulable phosphor sheet **20** independently of, i.e., separately from, the sheet feeder **32**. After the stimulable phosphor sheet **20** is separated from the sheet feeder **32** and temporarily stored in the storage zone **42**, the stimulable phosphor sheet **20** is gripped by only the first and second roller pairs **50**, **52** of the auxiliary scanning feed means **44** and fed in the auxiliary scanning direction indicated by the arrow A. Unlike the arrangement in which the stimulable phosphor sheet **20** is transferred from the sheet feeder **32** directly to the auxiliary scanning feed means **44** and two-dimensionally scanned thereby, the reading unit **36** does not require a nip releasing mechanism, which is relatively expensive, for releasing the stimulable phosphor sheet **20** from a nipping action of the roller pairs **38**, and hence is economical.

The image information reading apparatus **10** is relatively simple because it only needs to have, as additional components, the storage zone **42** with the guide plate **58** and the movable guide plate **60** actuatable by the solenoid **62** for switching between the paths. Since the stimulable phosphor sheet **20** is fed in the auxiliary scanning direction by only the auxiliary scanning feed means **44**, the radiation image information recorded in the stimulable phosphor sheet **20** can be read highly accurately.

In the first embodiment, after the stimulable phosphor sheet **20** fed by the sheet feeder **32** is delivered in the direction indicated by the arrow A by the auxiliary scanning feed means **44**, the auxiliary scanning feed means **44** is actuated in the reverse direction to store the stimulable phosphor sheet **20** into the storage zone **42**. The stimulable phosphor sheet **20** stored in the storage zone **42** is then fed in the auxiliary scanning direction by the auxiliary scanning feed means **44**, during which time the recorded radiation image information is read from the stimulable phosphor sheet **20** by the application of the laser beam L thereto (see FIGS. **3** through **5**).

However, after the stimulable phosphor sheet **20** has completely separated from the sheet feeder **32**, as shown, the recorded radiation image information may be read from the stimulable phosphor sheet **20** by the application of the laser beam L thereto while the stimulable phosphor sheet **20** is being fed in the auxiliary scanning direction indicated by the arrow B by only the auxiliary scanning feed means **44** (see FIG. **7**).

FIG. **8** shows in schematic vertical cross section an image information reading apparatus (scanning apparatus) **80** according to a second embodiment of the present invention. Those parts of the image information reading apparatus **80** which are identical to those of the image information reading apparatus **10** according to the first embodiment are denoted by identical reference characters, and will not be described in detail below.

The image information reading apparatus **80** includes a reading unit (scanning unit) **82** having a storage zone **84**. The storage zone **84** is positioned outwardly of the sheet feeder **32** and dimensioned so as to be able to store the entire length of the stimulable phosphor sheet **20**. The sheet feeder **32** has a movable guide plate **86** for selectively feeding the stimulable phosphor sheet **20** into the sheet feeder and the storage zone **84**. The movable guide plate **86** can be angularly moved by an actuator **88** such as a solenoid. The movable guide plate **86** and the actuator **88** jointly serve as a path switcher.

The image information reading apparatus **80** operates as follows: The stimulable phosphor sheet **20** delivered from the cassette **16** by the sheet feeder **32** is fed in the direction indicated by the arrow A by the auxiliary scanning feed means **44**. Then, the movable guide plate **86** is angularly moved by the solenoid **88** from the two-dot-and-dash-line position to the solid-line position, after which the auxiliary scanning feed means **44** is actuated in the reverse direction to temporarily store the stimulable phosphor sheet **20** into the storage zone **84**.

Thereafter, while the stimulable phosphor sheet **20** is being fed in the auxiliary scanning direction indicated by the arrow A by the first and second roller pairs **50**, **52** of the auxiliary scanning feed means **44**, the laser beam L is applied to the stimulable phosphor sheet **20** in the main scanning direction to read the recorded radiation image information from the stimulable phosphor sheet **20**.

In the second embodiment, inasmuch as the stimulable phosphor sheet **20** is temporarily stored in the storage zone **84**, the stimulable phosphor sheet **20** can fully be separated from the sheet feeder **32** and gripped and fed in the auxiliary scanning direction by only the auxiliary scanning feed means **44**. Therefore, as with the first embodiment, no mechanism for releasing the stimulable phosphor sheet **20** from a nipping action of the roller pairs **38** of the sheet feeder **32** is required.

FIG. **9** shows in schematic vertical cross section an image information reading apparatus (scanning apparatus) **100** according to a third embodiment of the present invention. Those parts of the image information reading apparatus **100** which are identical to those of the image information reading apparatus **10** according to the first embodiment are denoted by identical reference characters, and will not be described in detail below.

The image information reading apparatus **100** includes a cassette loading unit **18***a* and a sheet delivery mechanism **28***a* which are positioned in a lower portion of an apparatus housing, and a reading unit (scanning unit) **102** positioned in an upper portion of the apparatus housing. A sheet feeder **32***a* feeds the stimulable phosphor sheet **20** in the cassette **16** loaded in the cassette loading unit **18***a* to the reading unit **102**.

The reading unit **102** has a storage zone **104** comprising a guide plate curved upwardly. A movable guide plate **106** is angularly movably connected to an end of the guide plate for selectively feeding the stimulable phosphor sheet **20** into the sheet feeder **32***a* and the storage zone **104**. The movable guide plate **106** can be angularly moved by an actuator (not shown).

The image information reading apparatus **100** operates as follows: The stimulable phosphor sheet **20** is temporarily stored in the storage zone **104** when the movable guide plate **106** is turned upwardly. Thereafter, while the stimulable phosphor sheet **20** is being fed in the auxiliary scanning direction indicated by the arrow A by being gripped by only the auxiliary scanning feed means **44**, the laser beam L is applied to the stimulable phosphor sheet **20** in the main scanning direction to read the recorded radiation image information from the stimulable phosphor sheet **20**. Consequently, the reading unit **102** does not require a nip releasing mechanism for releasing the stimulable phosphor sheet **20** from a nipping action of the roller pairs **38** of the sheet feeder **32***a*, and hence is economical, as with the first and second embodiments.

In the second and third embodiments, after the stimulable phosphor sheet **20** is temporarily stored in the storage zones

84, 104, the recorded radiation image information is read from the stimulable phosphor sheet **20** while the stimulable phosphor sheet **20** is being fed in the auxiliary scanning direction by the auxiliary scanning feed means **44**. However, as described above with respect to the first embodiment with reference to FIG. **7**, the recorded radiation image information may be read from the stimulable phosphor sheet **20** while the stimulable phosphor sheet **20** is being fed into the storage zones **84**, **104**.

The first through third embodiments are directed to the image information reading apparatus **10**, **80**, **100** which read the recorded radiation image information from the stimulable phosphor sheet **20** and erase the remaining radiation image information from the stimulable phosphor sheet **20**. However, the principles of the present invention are also applicable to an image information reproducing apparatus for reproducing radiation image information on a photographic film.

As described above, in the method of and the apparatus for scanning the sheet-like member according to the present invention, since the scanning unit has the storage zone for separating the sheet-like member from the sheet feeder and temporarily storing the sheet-like member, the sheet-like member can be fed in the auxiliary scanning direction while being completely separated from the sheet feeder. Therefore, for feeding the sheet-like member in the auxiliary scanning direction, it is not necessary to provide a releasing mechanism for releasing the sheet-like member from the sheet feeder. Therefore, the scanning apparatus is relatively simple in structure and inexpensive to manufacture.

Although certain preferred embodiments of the present invention have been shown and described in detail, it should be understood that various changes and modifications may be made therein without departing from the scope of the appended claims.

What is claimed is:

1. A method of scanning a sheet-like member, comprising the steps of:

feeding the sheet-like member with a sheet feeder;

separating the sheet-like member in its entirety from said sheet feeder and storing the sheet-like member into a storage zone of a scanning unit;

feeding said sheet-like member from said storage zone separately from said sheet feeder in an auxiliary scanning direction, which is substantially perpendicular to a direction in which a light beam is deflected one-dimensionally, with only auxiliary scanning feed means of said scanning unit, and applying said light beam to said sheet-like member for thereby scanning said sheet-like member two-dimensionally; and

transferring said sheet-like member which has been scanned two-dimensionally to said sheet feeder.

2. A method according to claim **1**, further comprising the step of:

selectively feeding said sheet-like member into said sheet feeder and said storage zone with a path switcher.

3. A method of scanning a sheet-like member, comprising the steps of:

feeding the sheet-like member with a sheet feeder;

separating the sheet-like member in its entirety from said sheet feeder, and thereafter feeding said sheet-like member toward a storage zone of a scanning unit in an auxiliary scanning direction, which is substantially perpendicular to a direction in which a light beam is deflected one-dimensionally, with only auxiliary scanning feed means of said scanning unit, and applying said light beam to said sheet-like member for thereby scanning said sheet-like member two-dimensionally; and

transferring said sheet-like member which has been scanned two-dimensionally from said storage zone to said sheet feeder.

4. A method according to claim **3**, further comprising the step of:

selectively feeding said sheet-like member into said sheet feeder and said storage zone with a path switcher.

5. An apparatus for scanning a sheet-like member, comprising:

a sheet feeder for feeding a sheet-like member; and

a scanning unit for applying a light beam to said sheet-like member to scan the sheet-like member two-dimensionally;

said scanning unit comprising:

a storage zone for separating said sheet-like member in its entirety from said sheet feeder and temporarily storing said sheet-like member;

light beam deflecting scanning means for applying a light beam which is deflected one-dimensionally to said sheet-like member which has been separated from said sheet feeder; and

auxiliary scanning feed means for feeding said sheet-like member in an auxiliary scanning direction which is substantially perpendicular to the direction in which said light beam is applied.

6. An apparatus according to claim **5**, wherein said scanning unit further comprises:

a path switcher for selectively feeding said sheet-like member into said sheet feeder and said storage zone.

7. An apparatus according to claim **6**, wherein said path switcher comprises:

a movable guide plate; and

an actuator for angularly moving said movable guide plate.

8. An apparatus according to claim **5**, wherein said sheet feeder comprises roller pairs for gripping and feeding said sheet-like member.

9. An apparatus according to claim **5**, wherein said auxiliary scanning feed means comprises first and second roller pairs which are rotatable in synchronism with each other.

10. An apparatus according to claim **5**, wherein said storage zone has a curved guide plate having a dimension commensurate with the length of said sheet-like member in the direction in which the sheet-like member is fed.

11. An apparatus according to claim **5**, wherein said sheet-like member comprises a stimulable phosphor sheet.

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